

COMPARISON OF FEEDING SINGLE SOURCES AND COMBINATIONS
OF ANTIBIOTICS TO CAGED AND FLOOR LAYERS

by

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INTRODUCTION

Interest in the use of antibiotic supplements in rations for laying hens has attracted considerable attention in the past few years. It has stemmed from the popularity and widespread use of these additives in broiler and turkey rations. Due to these beneficial effects, it was felt that there was a possibility of some improved efficiency by using antibiotic additives in layer rations.

It is possible to present data which indicate that antibiotics improve egg production, hatchability, feed efficiency, egg quality, and the general health of birds. Likewise, it is possible to present data contrary to this.

The purpose of this research was to investigate use of antibiotics in layer rations, to present the results thus obtained, and to help alleviate the question as to whether the additives would be profitable.

With the advent of the recent indoctrination of the caged layer system in the midwest, it was felt that this problem should be studied in conjunction with the problem of floor layers.

Two experiments were conducted at the Kansas station to study the effects of low levels of antibiotics in both caged and floor layer rations. The reason for the two experiments was that birds of two different ages were used which would make the results difficult to interpret correctly.

January hatched pullets were used in Experiment I, to study the effects of various low levels of antibiotics and combinations of antibiotics. Phase 1 of this experiment was conducted to determine any beneficial effects from the addition of these additives to caged layer

rations. Phase 2 of this experiment was conducted to determine any beneficial effects from the addition of one antibiotic at a low level to floor layer rations.

April hatched pullets were used in Experiment II, to study the use of low levels of antibiotics and combinations of antibiotics, and to determine any beneficial effects from the addition of these additives to floor layer rations.

REVIEW OF LITERATURE

Following the discovery of Stokstad and Jukes (1950), that feeding chlortetracycline had a growth promoting effect on chicks, numerous research investigations followed which gave promising results with broilers. Prior to this time antibiotics had been known only as a constituent of the animal protein factor.

Carver and McGinnis (1951) prompted an interest in the effect of antibiotics on egg production, feed efficiency, liveability of hens, hatchability, egg quality, and incidence of blood and meat spots. One experiment was conducted using 40 White Leghorn pullets housed on straw litter and fed a soybean oil meal diet containing B_{12} and supplemented with 10 parts per million of oxytetracycline. Another diet in this experiment contained the basal and only 10 parts per million of chlortetracycline. In another experiment of 59 birds, the soybean oil meal basal was supplemented with 4, 8, and 12 parts per million of oxytetracycline. No outstanding results were obtained from feeding either chlortetracycline or oxytetracycline. Lillie and Bird (1952) found no improvement in low producing New Hampshire hens fed a B_{12} deficient ration supplemented with chlortetracycline. Later Lillie and Sizemore (1954) found

improvement in low producing New Hampshires but not in high producers. This diet was also deficient in vitamin B₁₂.

Confirmation of the earlier work of Bird was reported by Petersen and Lampman (1952). In this experiment, using duplicate lots of 65 White Leghorn pullets during their first year of production, streptomycin, oxytetracycline hydrochloride, and penicillin were added at a rate of nine grams per ton of feed. They concluded that antibiotics at a low level did not increase egg production, body weight, egg weight, liveability, or reduce losses from diseases such as avian leucosis or blue comb. Cravens (1954) stated that low levels thus far have not given any apparent improvement as reported by several other authors but that the problem needed further study.

Carpenter (1952-1953) reported there was not much to be gained by using antibiotics for egg production, feed conversion or mortality, except during early growth when the chicks were young.

Bearse and Berg (1955) reported that the addition of antibiotics to feed of good layers was not necessary; however, the birds did improve somewhat at the end of the laying year or if not in good health. With a field trial, Warden (1957) supplemented laying rations with zinc bacitracin, and observed it was economical to add 50 grams of antibiotic per ton of feed, when hens were in a period of depressed egg production.

Sunde et al. (1952), using Single Comb White Leghorns with and without vitamin B₁₂ and antibiotic at 0.1 percent, did not improve egg production. Hatchability was improved by the addition of vitamin B₁₂. The addition of an antibiotic supplement to a ration already containing vitamin B₁₂ did not result in improved hatchability. Halich

and Couch (1951) reported that aureomycin or penicillin helped deplete the bird of the B_{12} and unidentified factors. In a three year hatchability study, using New Hampshire hens, Johnson (1953) concluded that the addition of penicillin or choline did not alter the requirement for vitamin B_{12} . Neither progeny liveability, nor growth were affected by addition of choline and penicillin to the diet. Carpenter et al. (1954) reported similar findings in Ireland. The stimulation of early growth by feeding chlortetracycline did not materially affect the final weight of pullets, egg production, or incidence of broodiness.

Brown et al. (1953) found that feeding Single Comb White Leghorns an all mash ration of three different protein and energy levels, supplemented with penicillin at the rate of one pound per ton, resulted in no increased egg production, feed efficiency, hatchability, fertility, or maintenance of body weight.

Feeding for comparison of growth rate of pullets, Heywang (1952) found that when the diet was adequate in vitamin B_{12} there was no appreciable difference between the basal and a ration containing the antibiotic chlortetracycline, penicillin, streptomycin or the arsenical 3 nitro-4 hydroxy-phenyl-arsonic acid. Mariakulandai et al. (1952) found little effect on egg production or gain in weight by feeding oxytetracycline to White Leghorn pullets kept on wire floors. Hatchability was improved by the addition of antibiotics to a vitamin B_{12} deficient ration. By comparison, Petersen et al. (1952) found that hens reared on built up litter and fed the APF supplement produced eggs that hatched as well as those from hens fed one and five percent fish meal. The APF supplement prepared from chlortetracycline production

did not supply sufficient B_{12} to maintain hatchability of eggs from chickens kept on wire floors.

Rhode Island Red hens were reared on a feed supplemented with chlortetracycline according to Sizemore et al. (1955). This study revealed no influence of the chick diet upon mortality, egg production or fertility. Hens fed an antibiotic supplemented ration showed lowered embryonic mortality. Sizemore et al. (1952) found by feeding chicks chlortetracycline and vitamin B_{12} there was no influence of chick diet upon mature body weight, laying house mortality, egg production, fertility, egg weight, or shell thickness, unless the diet was deficient in vitamin B_{12} .

The addition to practical breeder mashes of 5 and 200 milligrams of penicillin per kilogram of feed resulted in greater biotin and folic acid deposition in the egg yolk. The hypothesis is that the antibiotic diminishes the microflora of the intestine, making more essential nutrients available. This experiment did not have any measurable effect on egg production, hatchability, body weight or egg weight over a 10 month period according to Waibel et al. (1952).

Carlson et al. (1952), using White Plymouth Rocks, found that egg production and hatchability were improved with some variations by supplementing with penicillin and streptomycin. Later Carlson and Kohnmeyer (1954) duplicated their earlier findings by getting significantly more eggs with procaine penicillin fed to New Hampshire pullets on a free-choice mash and grain diet. Barred Plymouth Rocks, which were showing 23 percent leucosis, produced more eggs than controls which appeared to be superior at housing time. Hatchability, progeny growth, and egg

quality were not consistently affected.

Carlson (1955) stated that hatchability of the layers which were poor producers or gave a submaximal hatchability benefited more from the addition of antibiotics.

Chin and Brant (1953) working with Rhode Island Red pullets, observed that supplements of chlortetracycline at 5, 10, 20, and 40 parts per million did not affect egg quality or shell quality. Blood spot size decreased as the chlortetracycline increased, in the month of April, but not in December.

Bentley and Hershberger (1954) reported that feeding of bacitracin, oxytetracycline, chlortetracycline HCl, or procaine penicillin did not consistently affect hatchability. However, in one experiment, both in the presence and absence of B₁₂, there was an improvement with either bacitracin or chlortetracycline HCl.

In a report from England, McDonald and McClymont (1953) stated that the addition of low levels of penicillin increased the growth rate of pullets to 12 weeks of age, but not to 36 weeks. Egg production and sexual maturity were not affected. McKay (1953) reported that in Ireland very little effect on egg production was noted with the feeding of penicillin or chlortetracycline.

Using both caged and floor layers, Sherwood and Milby (1953) reported that 20 grams of penicillin was without effect in increasing egg production.

Bearbe and Berg (1955) concluded there is not much to be gained from feeding chlortetracycline at any level to White Leghorn high producers, except possibly in the latter part of the year.

Birds maintained on low levels of chlortetracycline, penicillin, oxytetracycline, and bacitracin from one day until the end of the first year of lay were not significantly greater in egg production than the controls according to Boone and Morgan (1955). Cortes (1955), working in the Philippines, found that 0.5 percent chlortetracycline hastened sexual maturity, but egg production was not significantly affected.

Lillie et al. (1957) reported that in three experiments, using production type New Hampshire Crossbred pullets (New Hampshire x Cornish), and broiler type New Hampshires, there was no effect on egg production, fertility or hatchability at any level of penicillin G used.

Penicillin was non-effective for increasing egg production, feed efficiency, mortality, hatchability or fertility but did increase body weight according to Thornton and Moreng (1957). The level used was 14.6 grams of penicillin per ton of feed.

Petersen et al. (1958) fed White Leghorn pullets 0, 4, 20, and 100 grams procaine penicillin per ton of feed. They did not get an increase in egg production, egg weight, feed efficiency or liveability. Body weight was significantly increased with all levels fed. Egg shell thickness was not increased during hot weather. In this case, the hens maintained production above 70 percent.

On the other hand, Reid et al. (1951) increased egg production by the inclusion of one percent chlortetracycline APF or 66 milligrams of chlortetracycline hydrochloride per kilogram of feed in place of the APF. Egg production was not affected by substitution of crystalline vitamin B₁₂ for APF but was when added in conjunction with chlortetracycline.

Petersen et al. (1952) demonstrated that the inclusion of vitamin B₁₂ antibiotic feed supplements in an all vegetable ration, deficient in vitamin B₁₂, improved egg production. Using White Plymouth Rock and New Hampshire pullets, Carlson et al. (1953), demonstrated there was increased egg production, hatchability and improved progeny growth when the overall egg production was below 50 percent. The antibiotics used were penicillin, 24 grams per ton, and streptomycin, 60 grams per ton of feed.

Elam, et al. (1951, 1953) found that penicillin fed at 33 milligrams per kilogram of feed, improved egg production of crossbred hens receiving vitamin B₁₂ by injection. This work was confirmed by Carlson et al. (1953) who found also that penicillin and streptomycin was effective in this respect. The overall egg production of New Hampshires and White Rocks used in this experiment was below 50 percent. Kennard and Chamberlin (1953) fed 10 groups of New Hampshires a high energy ration well fortified with antibiotics and observed very good performance.

Gouch (1953, 1958) stated that from his laboratory as well as others there was an improved egg production of about 4 to 8 percent and about a 10 percent increase in hatchability by the addition of antibiotics. High levels were the most effective in these cases. Reid et al. (1957) found that egg production was increased and mortality decreased by the addition of antibiotics.

Anonymous workers (1955) using 2,300 White Leghorn pullets of different strains got increased egg production, feed efficiency and hatchability by feeding 60 to 100 grams of bacitracin methylene disalicylate per ton of feed.

Balloun (1954) reported that high levels of chlortetracycline increased egg production of New Hampshires that were in normally low production and housed on wire floors. Carlson (1954) reported that low levels of penicillin as well as high levels of chlortetracycline and streptomycin increased egg production. Carlson has stated that it would be a good insurance program to use when hens are under 70 percent production. Hatchability, progeny growth, and egg quality were not consistently affected.

Jukes (1954) reported that 2,916 New Hampshire hens infected with chronic respiratory disease were supplemented with 100 grams of chlortetracycline per ton of feed. They showed gradual increase in egg production, and by the final week of a 45 day experiment the treated birds laid 7.9 percent more eggs than the untreated group.

Klussendorf (1955, 1956), Bird (1955) and Anonymous workers (1957) stated that antibiotics at high levels will combat diseases and carry birds through stress conditions.

Cover (1955), using terramycin in oil, bicillin and streptomycin, antibiotic paste (streptomycin and penicillin), and terramycin in water found no significant improvement in the course of disease, mortality or egg production. The flocks were being treated for chronic respiratory disease.

Anonymous workers (1956) have reported that when hens were in a slump, an increase in production of 7.7 percent was obtained by feeding 100 grams of bacitracin per ton of feed, and an increase of 14 percent with a 200 gram level.

Anonymous workers (1957) reported no increased overall effect from feeding antibiotics, but that a substantial increase was observed in winter.

Heywang (1954) reported egg production was increased in a 100 day hot weather experiment, when the ration was supplemented with 50 and 100 grams of chlortetracycline per ton. With an experiment using 2,300 hens, Carlson et al. (1955) reported that antibiotic feeding improved feed efficiency, and egg production, particularly when the hens were fed a free-choice diet of mash and grain. Body weight, mortality, egg quality, and hatchability were not consistently affected. It was observed that at the onset of one experiment, the control group had been producing 50 percent while the group to be treated, involved with ocular leucosis, had been producing 42 percent. Following initiation of treatment, birds fed no antibiotic went into a slump; whereas, those fed a high level of 200 grams per ton of chlortetracycline maintained production of about the same level.

Single Comb White Leghorns were fed low and high levels of penicillin and streptomycin by Jacobs et al. (1955). At levels of 25 to 50 milligrams per pound of feed, egg production was increased 10 to 15 percent over a seven month period. Researchers from Penick research farm (Anonymous 1955) reported increased egg production and hatchability by feeding bacitracin, to 2,300 White Leghorn pullets of different strains.

"Low levels of antibiotics are profitable," is the comment by Thomas and Day (1957). They observed that terramycin increased egg production of hens in cages. The difference was not significant. They preferred high levels given intermittently.

Price et al. (1955) increased egg production with hens that were normally low in egg production by supplementing the ration with 5, 25, and 50 milligrams of bacitracin, penicillin, chlortetracycline, oxytetracycline and streptomycin per pound of feed. According to Ryan et al. (1957) an increase in egg production of 3.66 percent was observed when hens in the Storrs Egg Laying Contest were fed high levels of chlortetracycline. They reported also a better feed conversion with treated birds.

White-Stevens et al. (1955) reported that chlortetracycline fed at a level of 50 grams per ton for light breeds and 100 grams per ton for heavy breeds was optimum for increased egg production, reduced feed, enhanced hatchability, increased egg weight, and gave better results in stress conditions. Feeding layers in Viena, Amscheler et al. (1956), produced 25 percent more eggs on 22 percent less feed when feeding procaine penicillin at a low level to New Hampshire, Brown Leghorns and Crossbreds.

Naber (1956) stated that the addition of antibiotics to layer rations was a matter of economics and should be used for low producers below 60 percent.

Branion et al. (1956) found that feeding heavy breed hens 10 and 100 parts per million of chlortetracycline hydrochloride, increased egg production over a six months period. Couch (1956) using Single Comb White Leghorns and feeding 5, 50 and 100 grams of chlortetracycline, increased egg production four percent in one month, and eight percent in two months. He stated also that anything over 10 grams per ton helped birds out of slumps.

Chlortetracycline at four grams per ton or arsenalic acid, either when used alone, increased egg production, but when used together decreased it according to Carlson (1957). Creech and Couch (1957), feeding Single Comb White Leghorns the antibiotics penicillin, streptomycin or combinations of these, observed increased egg production and feed efficiency. The rates were 50 grams of penicillin, 100 grams of streptomycin, and 50 grams streptomycin plus 25 grams of penicillin per ton of feed.

Assem and Sanford (1956) reported that feeding chlortetracycline to Single Comb White Leghorns, subjected to stress, reduced the decrease in percentage of shell. Carson et al. (1954) observed increased egg production and a lessened decrease in shell percentage with birds under normal stress.

MATERIALS AND METHODS

All experiments were conducted at the Kansas State College poultry farm. In all, a total of 603 birds were used in two separate experiments. Two experiments were conducted since birds of two different ages were utilized.

The birds for both experiments were reared under normal poultry husbandry practices at the college poultry farm rearing range. They were vaccinated at the proper ages for Newcastle, bronchitis, and fowl pox.

All diets were mixed at the feed building located at the poultry farm. The control ration used was the Kansas State College basal layer ration, hereafter referred to as KSC basal ration, the composition of which is given in Table 40. It was prepared by weighing the macro

ingredients on a large platform scale and the micro ingredients were weighed on a computagram scale or analytical balance, depending on the amount to be weighed. The vitamins and minerals were premixed separately two times. They were first mixed for five minutes in a small electric Hobart mixer. Approximately 15 pounds of ground yellow corn was used as a carrier. The premixes were then mixed for another five minutes in a 100 pound horizontal mixer using approximately 75 pounds of ground yellow corn or ground grain sorghum. They were then added together with the macro ingredients into a 1000 pound horizontal type mixer. Extreme care was exercised at all times in order to keep the vitamins and minerals separated. To accomplish this, the mineral and vitamin premixes were added at different intervals. The entire KSC basal ration was then mixed for 15 minutes before being sacked off and tagged. To insure maximum freshness, the KSC basal ration was mixed at intervals not to exceed three weeks.

Buildings to house birds were of conventional frame construction. Waterers were automatic and ventilation was adequate. In some experiments coated electric wiring was used to prevent the water from freezing. No other form of heat was used.

With the exception of two birds deleted in Lots 4 and 5 of Experiment I, there was no culling. These two birds did not lay for several months. They were autopsied and found to be physiologically unable to lay. Records were readjusted accordingly.

Egg records were kept on a 28 day basis. Eggs were saved for three consecutive days at the end of each 28 day experimental period. After cooling to an even temperature in the basement room of the farm

office building, they were brought to the laboratory. A computagram scale was used for weighing the whole eggs. The average egg weight for the three days gave an average egg weight for that experimental period.

Immediately after weighing, the eggs were broken and the shells washed out with cool water. Observations were made for blood spots, meat spots, and interior quality. The shells were dried in a 90°F. oven for 24 hours. They were cooled for 10 minutes, and weighed on an analytical balance. The dry shell weight was recorded. The individual shell percentages were calculated from egg weight and dry shell weight.

Feed records were kept on a 56 day basis. Feed was added at various intervals throughout this period. A cumulative weight was kept. At the end of each 56 day period, the feed remaining was weighed and subtracted from the amount weighed out. The pounds of feed required to produce one dozen eggs was calculated on a hen day basis.

Body weights were recorded on an 84 day basis. At the end of each 84 day period, the birds were weighed and an average calculated.

Hatchability was checked two times during the course of Experiment I and three times during the course of Experiment II. Separate records were kept on a lot basis in all cases.

Analysis of variance was run on egg production, egg weight, percent shell, hatchability, feed per dozen eggs, and body weights for each respective period of study.

In Phase 1 of Experiment I, a different method of analyses was used. Mean egg weight, egg production, and percent shell were figured on an

average for a cage hen per 28 day period. Therefore a mixed model method of analysis of variance was used to show significance here. Also the Kramer (1956) method of multiple range test was used to locate significant differences in the cage lots because of unequal replications.

Duncan's (1955) method of analysis was used to locate differences in the remainder of the experiments.

Experiment I

Two hundred and three pullets of several different breeds and strains were brought from the poultry farm rearing range at the age of sexual maturity. This was approximately July 15, 1957. A complete list of the different strains are listed in Table 39. The birds were randomized as nearly equal as possible into two groups. The experiment composed of six cage lots and one floor lot was initiated on September 13, 1957. This experiment ran for a total of 10 - 28 day periods or 280 days.

Phase 1 (Cage) One group of 102 birds were again randomized for use in six lots of cage birds and the other group was used for the floor experiment. All cage lots consisted of 17 birds per lot. Birds were put into individual 10 inch cages which were equipped with facilities for watering and feeding.

Each lot was supplied with a metal container utilized for feed storage. A list of antibiotic supplements for this phase is listed as follows:

Lot 1 KSC basal ration plus 0 supplement.

Lot 2 KSC basal ration plus 10 grams chlortetracycline per ton of feed.

Lot 3 KSC basal ration plus 10 grams zinc bacitracin per ton of feed.

Lot 4 KSC basal ration plus 5 grams chlortetracycline
5 grams zinc bacitracin per ton of feed.

Lot 5 KSC basal ration plus 10 grams procaine penicillin per ton of feed.

Lot 6 KSC basal ration plus 5 grams procaine penicillin
5 grams zinc bacitracin per ton of feed.

Phase 2 (Floor) The other group containing 101 birds of several breeds and strains were housed on a concrete floor covered with straw litter. A list of these different strains are given in Table 39.

Feeders were of the cylindrical type, suspended from the ceiling of the building by ropes. Waterers were automatic, running almost the full length of the south side of the room occupied by the floor birds. They were cleaned at weekly intervals with a brush for sanitation purposes. Antibiotic supplement for this lot was the same as that for Lot 5 of Phase 1.

Experiment II

Four hundred pullets of the Ghostley Strain of White Leghorn were brought from the college poultry farm rearing range at the age of sexual maturity. This was October 3, 1957. This experiment ran for a total of 9 - 28 day periods or 252 days.

Birds were randomized into four equal lots of 100 each. They were housed on concrete floors with straw litter. Feeders were of the V-type elevated approximately two feet from the ground. They were equipped with platforms for the birds to stand on while eating. Waterers were of the cone type, automatic and free flowing. They were cleaned periodically for sanitation purposes and to prevent clogging of the drain.

The antibiotic supplements for this experiment were the same as for

Lots 1, 2, 3, and 4 of Experiment I, Phase 1. This experiment was initiated October 4, 1957.

RESULTS

Experiment I

Phase 1. Egg Production. An analysis of variance was run on the mean number of eggs laid per cage hen based on 10 - 28 day periods. This analysis indicated that treatments were significantly different at the .05 level, so the Kramer (1956) method of multiple range test for unequal number of replications was used to locate differences. The analysis of variance and table of ranked lots are given in Tables 1 and 2, respectively.

Data listed in Table 2 show that although Lot 1 produced more eggs, it was only significantly different from Lot 2, which produced the least, Lots 3, 4, 5 and 6 were not significantly different and Lots 2, 3, 4 and 5 were not significantly different.

Although the analysis of variance showed a significant difference at .01 level between individual hens within each lot, it was not felt this was a problem for study here.

Egg Weight. An analysis of variance was run on the mean egg weight per cage hen in the same manner as in Phase 1. This analysis indicated that a significant difference existed between lots at the .05 level, so the same method as before was used to locate these differences. The analysis of variance and table of ranked lots may be found in Tables 3 and 4, respectively.

The data tabulated in Table 4 show that although hens in Lot 5 laid the heaviest eggs, they were only significantly different from Lot 3, which were the least. Lots 4, 1, 6 and 2 were not significantly different and Lots 3, 4, 1 and 6 were not significantly different.

Although there was a significant difference at .01 level for hens within each treatment, it was felt this was not a problem for study here.

Shell percentage. An analysis of variance was run on the mean egg shell percentage in the same manner as in egg production. This analysis indicated that treatments were not significantly different at the .05 level. The analysis of variance is given in Table 5.

Although there was a significant difference at .01 level for hens within each treatment, it was not felt this was a problem for study here.

Hatchability. An analysis of variance was run on the mean hatchability percentage for two intermittent periods of study. This analysis indicated that treatments as well as the different periods were not significantly different at the .05 level. The analysis of variance is given in Table 6.

Feed Efficiency. An analysis of variance was run on the mean pounds of feed required to produce one dozen eggs. This was calculated on a hen day basis. This analysis indicated that treatments were not significantly different at the .05 level, but the different experimental periods were at the .01 level. The Duncan's (1955) method of locating differences among replicates with equal numbers was used to find this. The analysis of variance and the tables of ranked periods is given in Tables 7 and 8, respectively.

Data contained in Table 8 show that cage hens in this experiment ate significantly more feed in periods 3 and 4. This can be explained in that cooler weather existed during this time, therefore requiring more feed.

Body Weight. An analysis of variance was run on the mean body

weights on a lot basis. The analysis indicated there was a significant difference at the .01 level among lots as well as periods in which the weights were taken. To locate differences the same method was used as previously for hatchability. The analysis of variance, table of ranked lots, and table of ranked periods are given in Tables 9, 10 and 11, respectively.

Data listed in Table 10 show that Lots 1 and 6 had significantly higher body weights than the others, but were not significantly different from each other. Lots 5 and 1 had significantly higher body weights than Lot 3, but were not significantly different from each other. Lots 3 and 4 were not significantly different from each other.

Data tabulated in Table 11 show that hens gained significantly during the first period and then leveled off. Periods 2, 3 and 4 were significantly different from period 1, but were not significantly different from each other.

Comparison of Phase 1 (cage) and Phase 2 (floor). Egg Production.

An analysis of variance was run on the mean number of eggs laid by cage hens (5C) vs floor hens (5F) based on 10 - 28 day periods. This analysis revealed that treatments as well as experimental periods were significantly different at the .01 level so the Duncan's (1955) method of locating differences was used to locate these differences at the .05 level. The analysis of variance, table of ranked lots and table of ranked periods are given in Tables 12, 13 and 14, respectively.

Data contained in Table 13 show that the floor birds (5F) laid significantly more eggs than the cage birds (5C). Data compiled in Table 14 show that periods 1, 2 and 3 are all in a class to themselves.

They were the higher periods for egg production. Periods 4, 5, 6, 7, 8, 9 and 10 were not significantly different. Production leveled off after the fifth period.

Egg Weight. An analysis of variance was run on the mean egg weight of cage hens (5C) vs floor hens (5F). This analysis indicated that a significant difference at .01 level existed among treatments as well as experimental periods, so the same method was used as previously for egg production to locate differences in treatments and periods. The analysis of variance, table of ranked lots, and table of ranked experimental periods are given in Tables 15, 16 and 17, respectively.

Data listed in Table 16 show that eggs from cage hens were significantly larger than eggs from hens in floor pens. The data tabulated in Table 17 show that egg weight rose sharply starting with the fourth period. Periods 6, 7, 8 and 10 were significantly different and larger than the others, but were not significantly different from each other. The largest eggs were laid in Period 6 and the smallest in Period 1.

Shell Percentage. An analysis of variance was run on the mean shell percentage of cage (5C) vs floor (5F) eggs. The analysis indicated that treatments were not significantly different at the .05 level. Experimental periods approached significance; therefore, the same method was used as in egg production to locate any difference. The analysis of variance and table of ranked periods are given in Tables 18 and 19, respectively.

Results listed in Table 19 show that periods 6, 10 and 8 were significantly different from all others, but were not different from each other. It shows that period 7, 5, 3, 2, 4 and 1 were related in the same manner. Also that 6, 8, 7, 5 and 3 were related in the same manner

and that 10, 6, 7, 8 and 5 were related in the same manner.

Hatchability. An analysis of variance run on mean hatchability percentage revealed that neither cage 5 nor floor 5 treatments were significantly different at the .05 level. Also that the experimental periods were related similarly. The analysis of variance is given in Table 20.

Feed Efficiency. An analysis of variance was run on mean pounds of feed required to produce one dozen eggs in cage Lot 5 vs floor Lot 5. The analysis revealed that in this respect neither cage nor floor were significantly different at the .05. It was shown also that the experimental periods were related in likewise manner. The analysis of variance is given in Table 21.

Body Weights. An analysis of variance run on the mean body weights, based on four weight periods, was run on cage (5C) vs floor (5F) birds. The analysis revealed that a significant difference at the .05 level did not exist between them nor did a difference in period response exist in like manner. The analysis of variance is given in Table 22.

Experiment II

Egg Production. An analysis of variance was run on the lot mean number of eggs based on 9 - 28 day experimental periods. The analysis revealed that both treatments and experimental periods were significantly different at the .01 level, so the same method used as in Experiment I, Phase 1 and 2 was used to locate these differences at the .05 level. The analysis of variance and tables of ranked lots and periods are given in Tables 23, 24 and 25, respectively.

Data presented in Table 24 show that although individual antibiotics improved egg production, they were not significantly different from the control. Lot 4, which was a combination of two antibiotics, gave significantly more eggs than did any other lot. Results tabulated in Table 25 show that periods 8, 6, 7, 4 and 3 were not significantly different, and that 8, 6, 7 and 4 were not significantly different. Starting the third period, and with the exception of period 5, egg production was not significantly different, until the ninth period where it dropped.

Egg Weights. An analysis of variance was run on mean egg weight for the 9 - 28 day periods. This analysis revealed that egg weights of lots as well as different experimental periods were significantly different at .01 level. The same method was used as for egg production to locate these differences. The analysis of variance tables of ranked lots, and ranked periods are given in Tables 26, 27 and 28, respectively.

Results as presented in Table 27 show that Lots 1 and 3 were significantly different, and were larger than Lots 2 and 4. Lot 4 was significantly different from 3, 2 and 1. The data listed in Table 28 show that eggs increased in size starting at about the third experimental period; were constant for two periods, and then started decreasing in size. Eggs produced in periods 1 and 2 were quite small, and they got larger and remained somewhat the same after that.

Shell Percentage. An analysis of variance run in the same manner as for egg production revealed that treatments were not significantly different at .05 level, but that experimental periods were significantly different at .01 level. The same method was used as for egg production to locate these differences. The analysis of variance and table of

ranked experimental periods are given in Tables 29 and 30, respectively.

Data presented in Table 30 show that egg shell percentage was largest at the start, declined in the winter months, rose a little in the spring, and then declined to its lowest point during the last period.

Hatchability. An analysis of variance was run on the mean hatchability percentage of three intermittent periods. The analysis revealed that treatments were not significantly different, but the intermittent periods were significantly different at the .05 level. The same method was used as for egg production to locate these differences. The analysis of variance and table of ranked periods are given in Tables 31 and 32, respectively.

Results presented in Table 32 show that periods 1 and 2 are not significantly different from each other, but are significantly different from period 3.

Feed Efficiency. An analysis of variance was run on mean pounds of feed required to produce one dozen eggs. The analysis of variance revealed that the feed required to produce a dozen eggs was not significantly different at the .05 level. The analysis of variance and table of ranked experimental periods are given in Tables 33 and 34, respectively.

The data listed in Table 34 revealed that period 1 was significantly different from 2, 3 and 4. This may be explained by the fact that low egg production existed when the pullets were first coming into production. All other periods were not significantly different at the .05 level.

Body Weights. An analysis of variance was run on the mean body weight of each lot, based on four weigh periods. The analysis revealed that at the .05 level there was not a significant difference in body

weight of the different lots. There was, however, a significant difference at .01 level in experimental periods so the same method was used as for egg production to locate these differences. The analysis of variance and table of ranked experimental periods are given in Tables 35 and 36, respectively.

Results presented in Table 36 show that period 1 was significantly different from all others, that periods 2 and 3 were related and periods 2 and 4 were related. This means the birds gained weight early in the fall, but lost weight after onset of heavy production in the spring.

DISCUSSION

Results of egg production indicate there was a significant difference between treatments when using antibiotics at levels of 10 grams per ton of feed. In the case of caged layers, the use of single sources or combinations of antibiotics did not exert an increased effect as compared with the non-supplemented KSC basal control ration. This was in agreement with the work of Sherwood and Milby (1953), who found that levels up to 20 grams of antibiotics per ton of feed would not improve egg production of caged layers. It is not in agreement with the work of Elam et al. (1951) who reported increased egg production by the addition of low levels of penicillin (9 grams per ton) in the feed of caged layers. This was in disagreement with our work since it was found that penicillin at low levels did not improve egg production over the control.

It is the opinion of the writer that this problem needs further study.

In the case of supplementing the basal ration with 10 grams of penicillin per ton of feed--cage Lot 5 and floor Lot 5--there was a significantly greater increase in egg production under floor conditions than

under cage conditions. It should be noted that although cage eggs were fewer they were larger.

In studying low level antibiotic supplements with reference to floor layers it was found that only a combination of zinc bacitracin and chlortetracycline gave significantly greater egg production than the non supplemented controls. Although the egg production from additions of single antibiotics was not significantly greater than the controls, the birds fed antibiotics did produce more eggs.

These increases are in general agreement with the work of Reid et al. (1951), Lillie and Sizemore (1954), who found that chlortetracycline improved the egg production of low producing hens, Balloun (1954), Carlson and Kohlmeyer (1954), who found that egg production of physically inferior birds showing 23 percent avian leucosis was improved by feeding chlortetracycline, Jacobs et al., Carlson (1955), Ryan et al. (1957) and Boone et al. (1957), Reid et al., (1957) Thomas and Day (1957). In most instances some sort of stress conditions existed. The results are also in agreement with the work of Amachler et al. (1956) in Vienna. The results obtained are in contrast to the findings of Carver et al, Sunde et al, McGinnis and Carver (1951), Petersen and Lampman, (1952), Berg et al. (1952), Mariakulandai et al. (1952), Waibel et al. (1952), Brown et al. (1953), Sherwood and Milby (1954), Boone and Morgan (1955), Bearse and Berg (1955) and Thornton and Moreng (1957), who found no beneficial effects from the additions of antibiotics to layer rations. This work was also in contrast with work of Carpenter (1952-53) and McKay (1953) who found no beneficial effects from the addition of chlortetracycline or penicillin to layer rations in Ireland. This work does not agree with the work of Petersen et al. (1958) who found that egg production was not

increased by any level of procaine penicillin fed. In this case the birds maintained production above 70 percent.

Egg weights were significantly affected by treatments of antibiotics in cage layers, as well as in floor layers. Cage Lot 5 laid the largest eggs, but were not significantly different from any except Lot 3 which laid the smallest.

Lot 4 of the floor layers laid more eggs but did not lay larger eggs. Although Lot 1 laid the largest eggs, it was not significantly different from Lot 4 in this respect.

The data obtained from our floor work was not in agreement with White-Stevens et al. (1955), who reported an increased egg weight by using 50 grams of chlortetracycline. The work was in general agreement with the findings of Berg et al. (1952), Carpenter (1952-53), Sizemore et al. (1953), Heywang and Kemmerer (1955), and Petersen et al. (1958), who found that egg weights were not influenced by the addition of antibiotics.

Shell percentage is a measure of shell thickness. It was found that a significant difference in shell percentage at the .05 level did not exist in the cage birds, however the control gave the highest. There was not a significant difference between cage Lot 5 and floor Lot 5 in this respect. There was also not a significant difference between the lots of floor layers in this respect. The control gave the highest in all cases.

The floor work is in agreement with findings of Sizemore et al. (1953) Chin and Brant (1953), Heywang and Kemmerer (1955), Bearse and Berg (1955) and Petersen et al (1958), who found no increase in shell by adding antibiotics. It was in general disagreement with Anonymous workers (1957)

who observed the addition of oxytetracycline to feed for layers resulted in a strengthened egg shell. It should be noted that oxytetracycline was not used in this study.

There are a few reports that antibiotics will maintain shell percentage during stress conditions. Carson et al. (1953) maintained thickness during a case of CRD and Assem and Sanford (1956) retained shell percentage during an imposed stress by feeding antibiotics.

In all experiments, hatchability was unaffected by treatments with low levels of antibiotics. This agrees favorably with the work of Petersen et al. (1952), Berg et al. (1952), Mariakulandai et al. (1952), Waibel et al. (1952), Bird (1952), Lillie and Bird (1952), Brown et al. (1953), Bently and Hershberger (1954), Carlson and Kohlmeyer (1954), Sherwood and Milby (1954), Sizemore et al. (1955), Bearse and Berg (1955), Carlson et al. (1955), Lillie et al. (1957), and Anonymous workers (1957), who found no improvement in hatchability by adding antibiotics. Those workers finding beneficial effects from addition of antibiotics were Couch (1953), Jacobs et al. (1954-55), White-Stevens et al. (1955) and McDonald (1956).

There were no significant differences in the amount of feed required to produce a dozen eggs in cage or floor layers. Neither was there a significant difference in comparing cage 5 with floor 5 in this respect.

This is in agreement with the work of McGinnis and Carver (1951), Berg et al. (1952), Brown et al. (1953), Thornton and Moreng (1957) and Anonymous workers (1957) who found no improvement in feed efficiency by antibiotic additions. It is in general disagreement with Carlson et al. (1955), who found improved feed efficiency by the addition of antibiotics to layer rations.

There existed a significant difference at .01 level for body weight of cage layers in the different lots. Lot 6 attained the heaviest weight. There was not a significant difference between the comparison of cage Lot 5 and floor Lot 5 in this respect. There was not a significant difference in the body weights of floor layers.

The floor work is in general agreement with the work of Berg et al. (1952), Petersen and Lampman (1952), Sizemore et al. (1953), Brown et al. (1953), Carlson et al. (1955), Heywang (1956-57) and anonymous workers (1957), who found no improvement in body weights by feeding antibiotics. Our cage work was in general disagreement with the above research investigations.

Mortality records were kept on all birds in both experiments. It was quite variable in the cage birds. Due to breed differences, cage fatigue and avian leucosis, it was felt this problem could not accurately be measured in Experiment I. There was, however, substantially higher mortality among cage birds than the corresponding floor birds.

In Experiment II, however, the same strain and breed were used. Although the mortality in the entire experiment was very low, the mortality in Lot 4, where a combination of two antibiotics was used, mortality was only 50 percent as high as the control lot. Mortality percentages are given in Tables 41 for Experiment I and 42 for Experiment II.

Blood spots, meat spots, and interior egg quality were noted as the eggs were broken out. Antibiotic treatments did not appear to exert an effect in either experiment.

Overall egg production for the different lots as calculated on a hen housed basis are presented in Tables 37 and 38. Data tabulated in Table 37 show that although Lot 1 was the highest for cage birds when

the overall cage production was compared to floor, the floor Lot 5 was highest. Floor Lot 5 laid 5.9 percent more eggs than the equal number of cage birds taken together as an overall.

Results presented in Table 38 show that Lot 4 which was a combination of zinc bacitracin and chlortetracycline laid 4.4 percent better overall production than the control lot and 4.0 percent better production than any single antibiotic in Experiment II.

SUMMARY AND CONCLUSIONS

Two experiments were conducted using a total of 603 birds of different breeds and strains for testing the use of low levels of single sources of antibiotics and combinations of antibiotics in both cage and floor layer rations. The two experiments included birds of two different ages.

Experiment I involved the period of September 13, 1957 to June 13, 1958 (10 - 28 day periods); whereas, Experiment II was initiated October 4, 1957 and was terminated June 20, 1958 (9 - 28 day periods).

Experiment I included birds of several different breeds and strains which are listed in Table 39 of the appendix. Phase 1 of this experiment involved a study of cage layers. Seventeen birds were put into individual cages for each of the six lots. At a later date one bird was deleted from Lot 4 and one from Lot 5 because of physiological defects. Records were adjusted accordingly. Lot 1 was used as the control for the other five lots. The K.S.C. basal ration was used as the control ration. Ten grams of single sources or combinations of antibiotics per ton of feed were added to the other treatments in the following manner.

Lot 2 (10 gms. chlortetracycline / ton of feed).

Lot 3 (10 gms. zinc bacitracin / ton of feed).

Lot 4 (5 gms. zinc bacitracin + 5 gms. chlortetracycline / ton of feed).

Lot 5 (10 gms. procaine penicillin / ton of feed).

Lot 6 (5 gms. zinc bacitracin + 5 gms. penicillin / ton of feed).

There was no significant improvement for egg production, egg weight, percent shell, hatchability, feed efficiency, body weights, meat spots, blood spots, or interior quality from the addition of low levels of single sources of antibiotics or combinations of antibiotics to caged layer rations.

Phase 2 of this experiment was the comparison of cage Lot 5 with floor Lot 5. The addition of a single source of antibiotic at a low level to these rations was as follows:

Lot 5 (both cage and floor 10 gms. penicillin / ton of feed).

In this phase the floor Lot 5 birds laid significantly more eggs than did the cage Lot 5 birds. A comparison of total egg production for all cage lots and floor Lot 5 revealed that the floor birds laid 5.9 percent more eggs for the 280 days the experiment was in progress. On the other hand, cage Lot 5 laid significantly larger eggs than did floor Lot 5. There was not a significant difference between cage Lot 5 and floor Lot 5 for shell percentage, hatchability, feed efficiency, or maintenance of body weight.

Experiment II involved four lots of 100 birds each of Ghostley Strain White Leghorns. Treatments included in this experiment had the same antibiotic additions as Lots 1, 2, 3 and 4 of Experiment I. This experiment ran for 252 days, (9 - 28 day periods). There were significantly more

eggs laid by birds receiving low levels of a combination of two antibiotics than the control or any single source of antibiotic. Single sources, however, did not significantly differ from the control lot in this respect. The overall hen housed egg production for the entire 252 day experiment was 4.4 percent higher for combinations of antibiotics than the control.

Supplementing the basal ration with antibiotics did not result in effect on shell percentage, hatchability, feed efficiency, or maintenance of body weight.

Mortality showed a treatment difference in both experiments. Data recorded in Table 41 reveals that antibiotics did not reduce the mortality in Experiment I (cage birds). These birds were inflicted with avian leucosis, cage fatigue, and were of different breeds and strains. Mortality was much higher among cage birds than floor birds. However, in Experiment II, the mortality of birds fed a combination of two antibiotics was only 50 percent as great as the control birds. It was felt that since all birds were of the same breed and strain this was accurately measured.

Supplementing the ration with antibiotic, did not appear to cause any effect on blood spots, meat spots or interior egg quality in either experiment.

The following conclusions were drawn from the data collected in these experiments.

(1) There was not a significant increase in egg production, egg weight, percentage shell, hatchability, feed efficiency, mortality, interior quality, meat spots, or blood spots by the addition of 10 grams per ton of feed of a single source or combinations of two antibiotics

to caged layer rations. (It is the opinion of the writer that this problem needs further study due to possible treatment position within the building and/or breed differences).

- (2) Caged layers laid significantly larger eggs than floor layers.
- (3) Floor layers laid significantly more eggs than caged layers.
- (4) There was not a significant difference in percentage shell, hatchability, feed efficiency, maintenance of body weight, meat spots, blood spots, or mortality from the addition of 10 grams per ton of feed of a single antibiotic (penicillin) to a cage layer ration vs a floor layer ration.

(5) A significant increase in egg production of floor layers was obtained by supplementing the KSC basal with a combination of two antibiotics at the level of 10 grams per ton of feed as compared with 10 grams of single sources of antibiotic or the non supplemented control ration.

(6) There was a non significant increase in egg production of floor layers with the addition of 10 grams per ton of feed of single sources of antibiotics as compared with the control.

(7) There was a non significant increase in egg weight, shell percentage, hatchability, feed efficiency, maintenance of body weight, and no noticeable improvement in interior quality, meat spots or blood spots by feeding 10 grams per ton of feed of a single source or combinations of antibiotics to floor layers.

(8) Mortality was less among floor layers than caged layers.

(9) Mortality was less with a combination of two antibiotics at a level of 10 grams per ton of feed for floor layers.

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APPENDIX

Table 1. Experiment I, Phase 1, analysis of variance of mean number of eggs laid per cage hen per experimental period. (Average of 10 - 28 day periods.)

Source of variation :	Degrees of freedom :	Sum of squares :	Mean square :	F-ratio
Treatment	5	1471.46	294.292	3.077 *
Hens: within treatments	92	8797.74	95.628	4.673 **
Error	800	16,371.11	20.464	
Total	897	26,640.31		

* Significant $P < .05$

** Significant $P < .01$

Table 2. Ranked lots based on Duncan's (1955) method for data presented in Table 1. 1/

2	5	4	3	6	1
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1/ Any two lots not underscored by the same line are significantly different, and any two lots underscored by the same line are not significantly different.

Table 3. Experiment I, Phase 1, analysis of variance of mean egg weight per cage hen per experimental period. (Average of 10 - 28 day periods.)

Source of variation :	Degrees of freedom :	Sum of squares :	Mean Square :	F-ratio
Treatments	5	1,522.05	304.410	2.367 *
Hens: within treatments	91	11,701.10	128.583	10.749 **
Error	697	9,034.31	12.962	
Total	793	22,257.46		

* Significant $P < .05$

** Significant $P < .01$

Table 4. Ranked lots based on Duncan's op. cit. method for data in Table 3.

3	4	1	6	2	5

Table 5. Experiment I, Phase 1, analysis of variance of mean shell percentage per cage hen per experimental period. (Average of 10 - 28 day periods.)

Source of variation :	Degrees of freedom :	Sum of squares :	Mean Square :	F-ratio
Treatments	5	30.39	6.078	0.966 NS
Hens: within treatments	91	572.75	6.294	13.42 **
Error	702	329.44	0.469	
Total	798	932.58		

NS Non Significant

** Significant $P < .01$

Table 6. Experiment I, Phase 1, analysis of variance of mean hatchability percentages. (Based on 2 intermittent periods).

Source of variation :	Degrees of freedom :	Sum of squares :	Mean Square :	F-ratio
Treatments	5	552.240	110.448	4.523 NS
Periods	1	5.960	5.960	0.244 NS
Error	5	122.090	24.418	

NS Non significant

Table 7. Experiment I, Phase 1, analysis of variance of mean pounds of feed per dozen eggs produced. (Based on 5 - 56 day periods.)

Source of variation:	Degrees of : freedom :	Sum of : squares :	Mean : square :	F-ratio
Treatments	5	1.72	0.344	0.573 NS
Periods	4	17.30	4.325	7.208 **
Error	20	11.99	0.600	

NS Non significant

** Significant $P < .01$

Table 8. Ranked periods based on Duncan's op. cit. method for data in table 7.

1	5	2	3	4

Table 9. Experiment I, Phase 1, analysis of variance of mean body weights. (Based on average of 4 weigh periods.)

Source of variation :	Degrees of : freedom :	Sum of : squares :	Mean : square :	F-ratio
Treatments	5	1.78	0.356	23.733 **
Periods	3	0.56	0.187	12.467 **
Error	15	0.22	0.015	

** Significant $P < .01$

Table 10. Ranked lots based on Duncan's op. cit. method for data in Table 9.

3	4	2	5	1	6

Table 11. Ranked periods based on Duncan's op. cit. method for data in Table 10.

1	3	2	4

Table 12. Experiment I, Phase 1 and 2, analysis of variance of mean number of eggs laid per cage hen (5C) vs floor (5F).

Source of variation :	Degrees of : freedom :	Sum of : squares :	Mean : square :	F-ratio
Treatments	1	8.45	8.450	11.835 **
Periods	9	57.47	6.386	8.944 **
Error	9	6.43	0.714	

** Significant $P < .01$

Table 13. Ranked treatments based on Duncan's op. cit. method for data in Table 12.

5C	5F

Table 14. Ranked periods based on Duncan's op. cit. method for data in Table 12.

7	10	6	8	9	4	5	3	2	1

Table 15. Experiment I, Phase 1 and 2, analysis of variance of egg weights of cage (5C) vs. floor (5F).

Source of variation :	Degrees of freedom :	Sum of squares :	Mean square :	F-ratio
Treatments	1	38.500	38.500	176.606 **
Periods	9	73.860	8.207	37.647 **
Error	9	1.960	0.218	

** Significant $P < .01$

Table 16. Ranked treatments based on Duncan's op. cit. method for data in Table 15.

5F	5C

Table 17. Ranked periods based on Duncan's op. cit. method for data in Table 15.

1	2	3	4	9	5	10	8	7	6

Table 18. Experiment I, Phase 1 and 2, analysis of variance of percentage shell of cage (5C) vs. floor (5F).

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatments	1	0.080	0.080	2.105 NS
Periods	9	1.060	0.118	3.105 NS ^{1/}
Error	9	0.340	0.038	

NS Non significant

^{1/} Indicates approaches significance at .05 level.

Table 19. Ranked periods based on Duncan's op. cit. method for data in Table 18.

10	6	8	7	5	3	2	4	1

Table 20. Experiment I, Phase 1 and 2, analysis of variance of hatchability percentages of cage (5C) vs floor (5F).

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatments	1	79.930	79.930	30.589 NS
Periods	1	4.290	4.290	2.715 NS
Error	1	1.580	1.580	

NS Non significant

Table 21. Experiment I, Phase 1 and 2, analysis of variance of mean pounds of feed per dozen eggs of cage (5C) vs floor (5F).

Source of variation	Degrees of freedom	Sum of squares	Mean square	F-ratio
Treatments	1	0.88	0.880	3.745 NS
Periods	4	2.06	0.515	2.191 NS
Error	4	0.94	0.235	

NS Non significant

Table 22. Experiment I, Phase 1 and 2, analysis of variance of body weights of cage (5C) vs floor (5F).

Source of variation :	Degrees of freedom :	Sum of squares :	Mean square :	F-ratio :
Treatments	1	0.030	0.030	1.765 NS
Periods	3	0.300	0.100	5.882 NS
Error	3	0.050	0.017	

NS Non significant

Table 23. Experiment II, analysis of variance of mean number of eggs per lot. (Based on 9 - 28 day periods).

Source of variation :	Degrees of freedom :	Sum of squares :	Mean square :	F-ratio :
Treatments	3	93,983.40	31,327.80	8.687 **
Periods	8	7,543,235.60	942,904.45	261.447 **
Error	24	86,555.60	3,606.48	

** Significant $P < .01$

Table 24. Ranked lots per lot based on Duncan's op. cit. method for data in Table 23.

1	3	2	4

Table 31. Experiment II, analysis of variance of hatchability percentages. (Based on 3 intermittent periods.)

Source of variation :	Degrees of : freedom :	Sum of : squares :	Mean : square :	F-ratio
Treatments	3	46.160	15.387	0.619 NS
Periods	2	473.970	239.435	9.634 *
Error	6	149.120	24.853	

NS Non significant

* Significant $P < .01$

Table 32. Ranked periods based on Duncan's op. cit. method for data in Table 31.

3	1	2

Table 33. Experiment II, analysis of variance of mean pounds of feed per dozen eggs laid. (Based on 5 - 56 day periods).

Source of variation :	Degrees of : freedom :	Sum of : squares :	Mean : square :	F-ratio
Treatments	3	0.31	0.103	2.943 NS
Periods	4	24.65	6.162	176.057 **
Error	12	0.42	0.035	

NS Non significant

** Significant $P < .01$

Table 34. Ranked periods based on Duncan's op. cit. method for data in Table 33.

5	4	2	3	1

Table 35. Experiment II, analysis of variance of mean body weights. (Based on an average of 4 weigh periods).

Source of variation :	Degrees of : freedom :	Sum of : squares :	Mean : square :	F-ratio
Treatments	3	0.020	0.007	2.333 NS
Periods	3	2.770	0.923	307.667 **
Error	9	0.030	0.003	

NS Non significant

** Significant $P < .01$

Table 36. Ranked periods based on Duncan's op. cit. method for data in Table 35.

1	4	2	3

Table 37. Experiment I, overall hen housed production percentages for the different lots (Based on 10 - 28 day periods).

Lot 1	2	3	4	5	6	5F
69.2%	47.9%	51.7%	53.8%	57.5%	57.4%	62.1%
Cage overall 56.2%				vs	Floor 62.1%	

Table 38. Experiment II, overall hen housed production percentages for different lots. (Based on 9 - 28 day periods).

Lot 1	Lot 2	Lot 3	Lot 4
61.1%	61.5%	61.4%	65.5%

Table 39. Breeds and strains used in Experiment I, Phase 1 (Cage) and Phase 2 (Floor).

	1C	2C	3C	Lot 4C	5C	6C	Totals	5F
Cornell Leghorn	: 4	4	3	3	3	4	21	21
DeKalb 111	: 1	1	2	2	1	1	8	8
DeKalb 101	: 3	3	3	3	3	3	18	17
Hy-Line 123	: 3	3	3	3	4	4	20	20
Cornell Leg x Purdue RIR	: 4	3	3	3	3	3	17	19
Purdue RIR x Cornell Leg	: 1	1	1	1	1	1	6	10
Hy-Line 934 A	: 1	2	2	2	2	1	10	6
Totals		17	17	17	17	17	102	101

Table 40. Composition of K.S.C. basal layer ration.

Corn, yellow, ground	15.00 lbs.
Grain sorghums, ground	50.00 "
Alfalfa meal, 17% prot. dehyd.	2.50 "
Wheat shorts, standard, gray	10.00 "
Soybean oil meal, 44% prot. solv extr.	10.00 "
Fish meal, menhaden, 60% prot.	2.00 "
Fish solubles, 50% prot.	0.50 "
Meat and bone scraps	3.00 "
Soluferm 500	2.00 "
Ground limestone	3.75 "
Steamed bone meal	1.00 "
Salt	0.25 "
Total	100.00 lbs.

Added per 100 pounds of ration

Choline choline (25% mix)	76.00 gms.
Riboflavin 3.63	30.00 "
Pantothenic acid, cryst.	00.39 "
Niacin cryst.	00.77 "
Vitamin A (10,000 IU per gram)	30.00 "
Vitamin D ₃ (3,000 ICU per gram)	15.00 "
D-L Methionine, feeding grade	23.00 "
Manganese sulphate	23.00 "

Table 41. Experiment I, Phases 1 and 2, showing mortality by lots. (Based on 10 - 28 day periods).

Lot 1	2	3	4	5	6	5F
5.88%	11.76%	23.53%	6.25%	6.25%	17.65%	7.92%
			Cage overall		Floor (5F)	
			12.00%		vs	7.92%

Table 42. Experiment II, percent mortality by lots. (Based on 9 - 28 day periods).

Lot 1	Lot 2	Lot 3	Lot 4
6.00%	5.00%	7.00%	3.00%

COMPARISON OF FEEDING SINGLE SOURCES AND COMBINATIONS
OF ANTIBIOTICS TO CAGED AND FLOOR LAYERS

by

CARL RAYMOND JOHNSTON

B. S., University of Arkansas, 1952

AN ABSTRACT OF A THESIS

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Two experiments were conducted in an effort to determine the effect of feeding various low levels of antibiotics or combinations of antibiotics to caged and floor layers.

In all a total of 603 pullets were used in both experiments. They were reared under normal poultry husbandry practices. They were vaccinated at the proper ages for Newcastle, bronchitis, and fowl pox. Feed for all hens was the Kansas State College basal layer ration, hereafter referred to as the KSC basal. All feed was mixed at the poultry farm.

Experiment I, containing 203 January hatched pullets of several different breeds and strains was initiated on September 13, 1957 and ran for a total of 280 days (10 - 28 day periods). The group was divided into two groups as evenly as possible. One group of 102 birds was then randomized into six equal lots of 17 birds each and put into individual cages. One bird was later deleted from each of two lots due to physiological incapacibilities. The other group of 101 birds was put into an adjacent pen on concrete floors covered with straw litter. Antibiotic supplements for the six cage lots were as follows:

Lot 1 KSC basal ration plus 0 supplement

Lot 2	"	"	"	"	10 grams chlortetracycline	per ton of feed				
Lot 3	"	"	"	"	10 grams zinc bacitracin		"	"	"	"
Lot 4	"	"	"	"	5 grams chlortetracycline + 5 grams zinc bacitracin		"	"	"	"
Lot 5	"	"	"	"	10 grams procaine penicillin		"	"	"	"
Lot 6	"	"	"	"	5 grams procaine penicillin + 5 grams zinc bacitracin		"	"	"	"

The floor pen adjacent to the cages had the antibiotic corresponding to Lot 5 and therefore was designated Lot 5 F.

Experiment II included four equal lots of 100 birds each. They were April hatched Ghostley Strain of White Leghorns. This experiment was begun October 4, 1957 and was run for a total of 252 days (9 - 28 day periods). Antibiotic supplements for the four lots corresponded to cage Lots 1, 2, 3, and 4 of Experiment I.

Egg records for both experiments were kept on a 28 day basis, feed records on a 56 day basis and body weights on an 84 day basis. Hatchability was checked two times for Experiment I, and three times for Experiment II. Mortality was recorded on a lot basis. Interior egg quality, meat spots, and blood spots were recorded as the eggs were broken out.

Each 28 days, eggs were saved for three consecutive days, cooled overnight, weighed individually, broken out, and observations made for interior quality, blood spots and meat spots. The shell was rinsed with water and placed in a 90°F. oven for 24 hours. After drying, the shells were cooled for 10 minutes, and weighed on an analytical balance. The shell weight was recorded, and the shell percentage calculated from the dry shell weight and egg weight. This gave an average for each 28 day period.

At various intervals, feed was added to each lot of birds. At the end of each 56 days, the feed remaining was reweighed, and the pounds of feed required to produce one dozen eggs was calculated.

At the end of each 84 day period, the body weights were recorded and averaged on a lot basis.

Analyses of variance were run on egg production, egg weight, shell percentage, hatchability, feed efficiency, and body weight, for each respective set of experimental periods.

For Experiment I there was not a significant increase in egg production, egg weight, percent shell, hatchability, or feed efficiency, and no improvement in mortality, interior egg quality, meat spots, or blood spots resulting from supplementing with 10 grams per ton of feed of a single antibiotic or combination of two antibiotics for caged layers.

There were significantly more eggs laid by floor layers than cage layers, but the caged layers laid significantly larger eggs. There was considerably more mortality among caged layers than floor layers. Since the caged birds were inflicted with avian leucosis, cage fatigue, and were of different breeds and strains, it was felt this problem could not accurately be measured. There was not a significant difference in shell percentage, hatchability, feed efficiency, or body weights between cage and floor comparisons, and no noticeable difference in interior egg quality, meat spots or blood spots.

In Experiment II, there were significantly more eggs laid by the birds receiving a combination of two antibiotics at a level of 10 grams per ton of feed in floor layer rations. Although egg production from birds receiving 10 grams of a single antibiotic per ton of feed was greater, it was not significantly greater than the control group. There was not a significant increase in egg weight, percent shell, hatchability, feed efficiency, or body weights resulting from supplementing with a single antibiotic or a combination of two antibiotics at 10 grams per ton of feed for floor layers. Mortality was considerably less for the birds receiving a combination of two antibiotics. Lots receiving a single

antibiotic had mortality equal to or greater than the control. There was no detectable difference in interior egg quality, blood spots, or meat spots of eggs of floor layers of any treatment or the control ration.